

NHTSA Forward Lighting Research

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OUTLINE

- **Glare complaints and problems**
- **Differences between HID and Halogen headlamps**
- **Factors affecting Discomfort and Disability glare**
- **Hypotheses about glare complaints**
- **Preliminary research findings**
- **Future research directions**

Forward Lighting Glare Concerns

- **Over 4900 responses to request for comments on glare**
- **Public wanted reduced glare from:**
 - **Auxiliary Lamps**
 - **Fog Lamps**
 - **Driving Lamps**
 - **Auxiliary Low Beam Lamps**
 - **High-mounted headlamps**
 - **High Intensity Discharge (*HID*) Lamps**

Glare Consequences Identified by Public

- **Causes annoyance and road rage**
- **Reduces vision**
- **Increases difficulty of using mirrors**
- **Distracts drivers; Causes eyes to look away from road**
- **Causes drivers to stop driving at night**
- **It hurts the eyes**
- **Causes fear of being in crash**

National Survey

Glare has been:

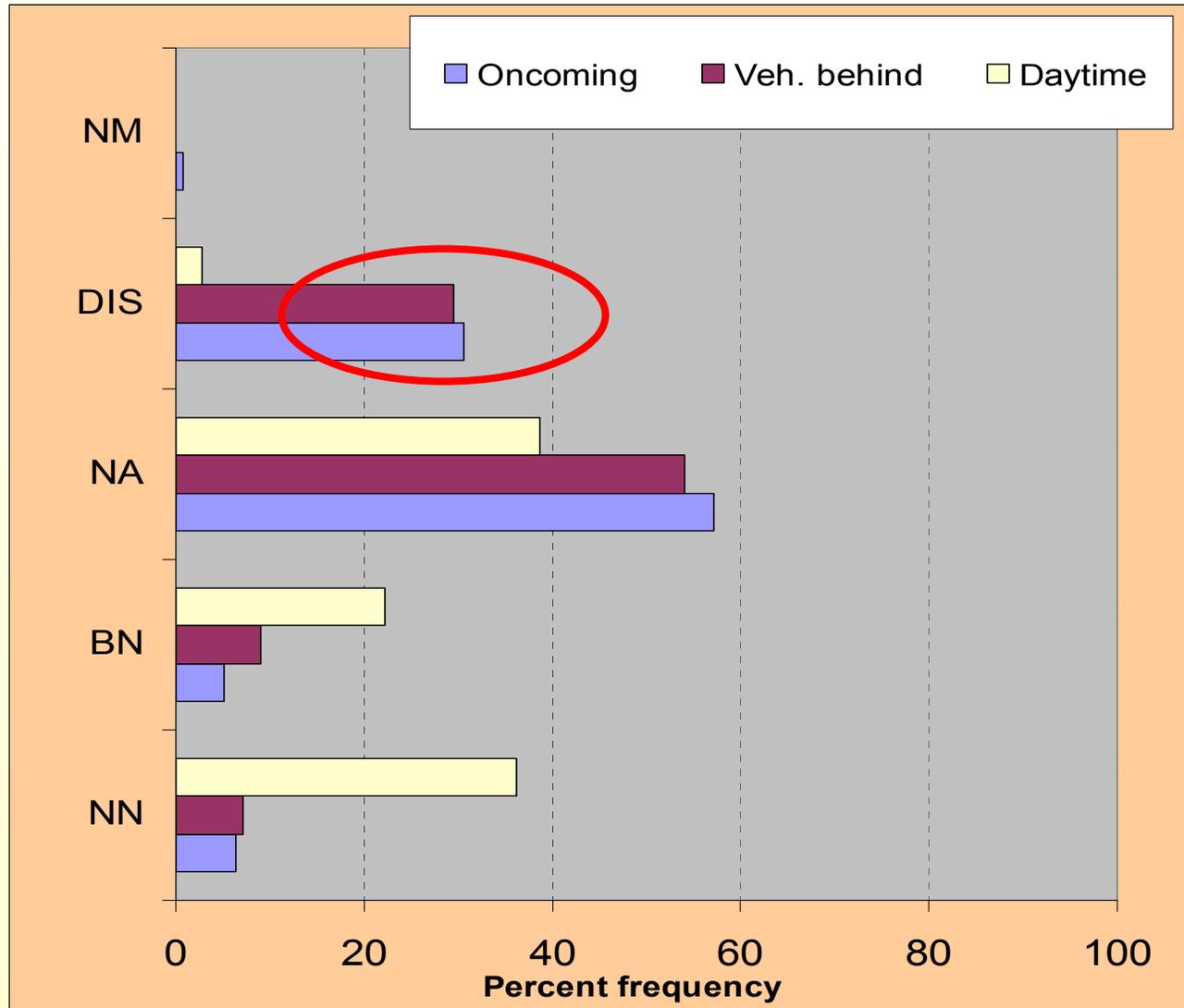
-Cause of crash,
Near Miss

-Disturbing

-Noticeable but
Acceptable

-Barely
Noticeable

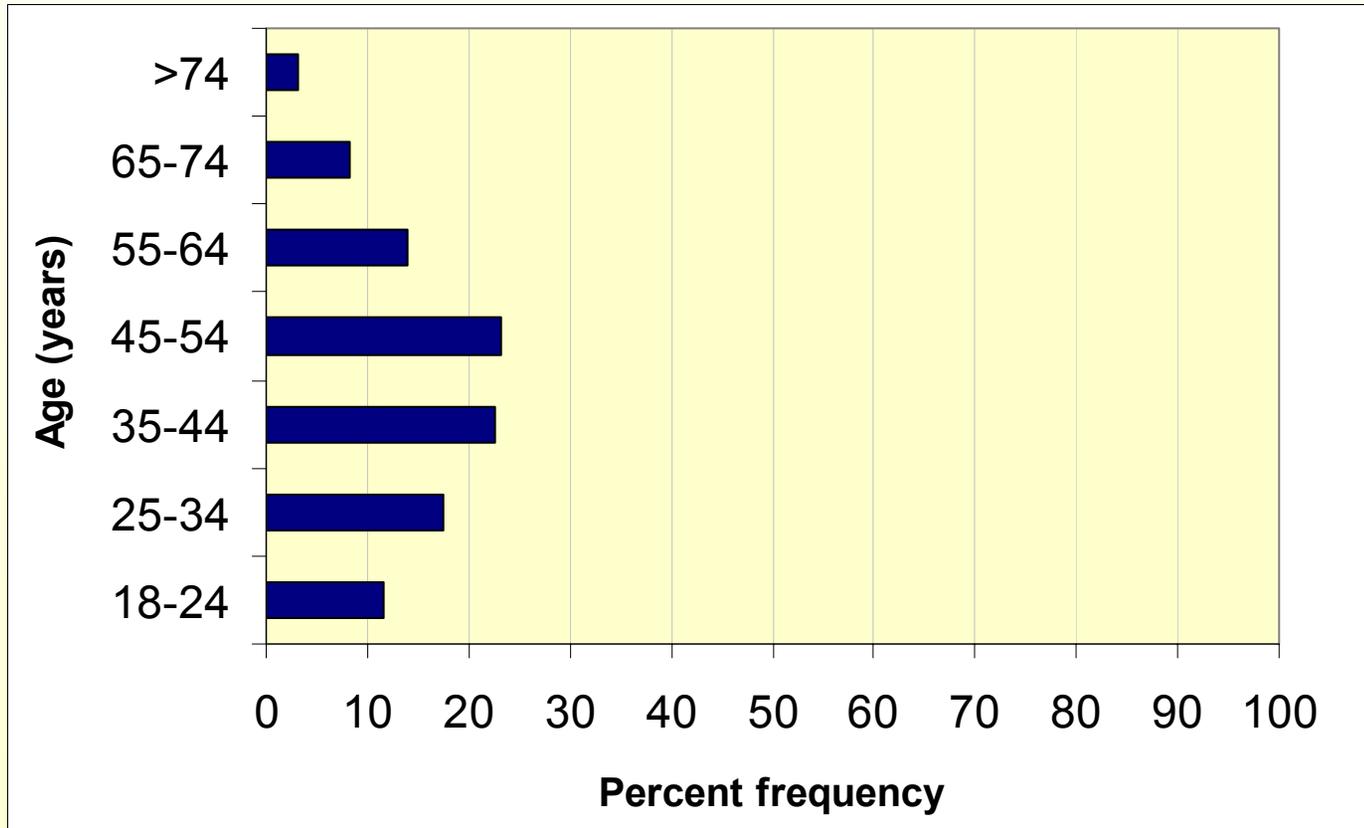
-Not Noticeable



From Bureau of Transportation
Statistics, 2002

(sample size~4321)

Oncoming Glare Rated 'Disturbing' by Each Age Group



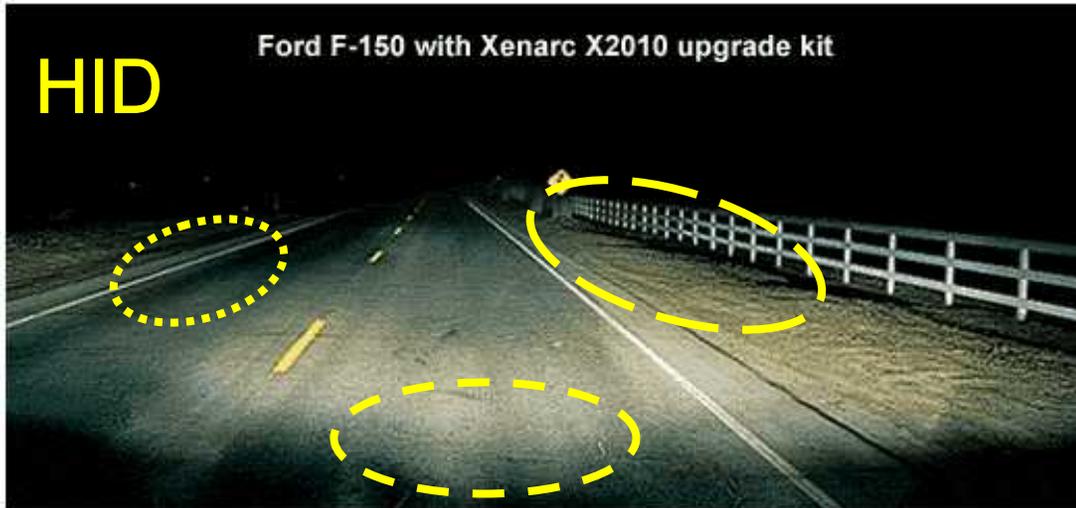
From Bureau of Transportation Statistics, 2002

Sample size ~ 1373

Key Research Questions

- **Why are drivers complaining about headlamp glare?**
- **What rulemaking options might reduce glare problems?**
 - **New photometric specifications**
 - **Reduced mounting height**
 - **Improved aim (static and dynamic)**
 - **Others (e.g., washing systems, lamp color)**

HID vs Halogen

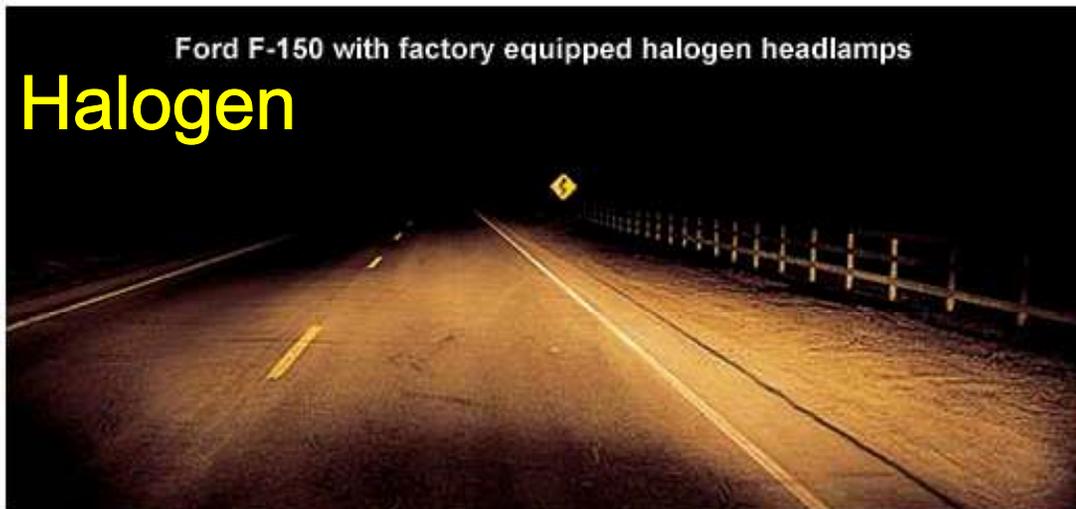


- Color

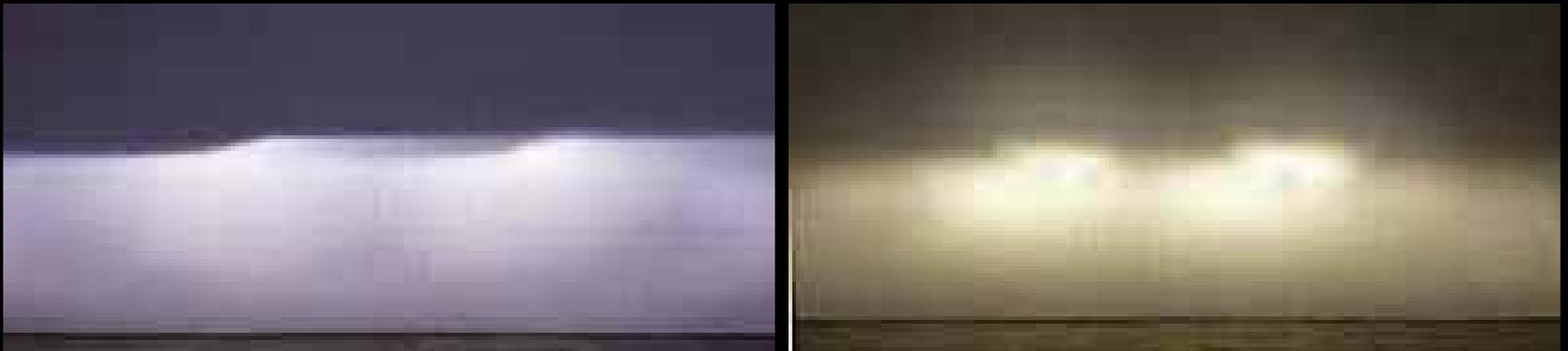
Blue/white vs.
Yellow

- Horizontal Intensity

Wide spread vs.
limited spread



HID vs Halogen



**Intensity Gradient:
Sharp Cutoff vs Gradual**

**Lens Optics:
2002 Mercedes Benz E/C Class**



**Projector optics:
2002 Audi A6**

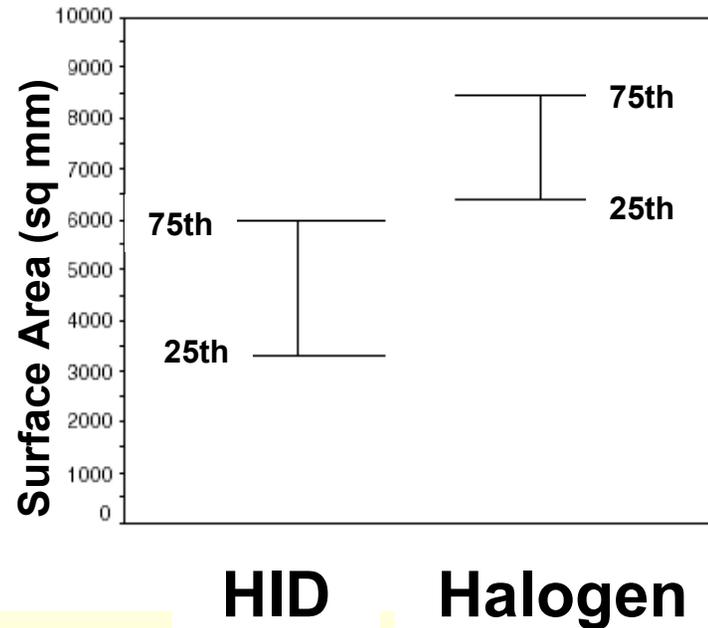


**Complex reflector optics
2003 Acura RL**



Lamp Design Differences

- Lamp size
(luminous area)



- Aiming methods

From UMTRI
research, 2002

Two Types of Glare

- **Discomfort**

- **Subjective, measured w/De Boer scale**

Just Noticeable		Satisfactory		Just acceptable		Disturbing		Unbearable
9	8	7	6	5	4	3	2	1

- **Influenced by: illuminance from glare source, task difficulty, ambient brightness, angle from line of sight**
 - **May affect performance through distraction and eye strain**

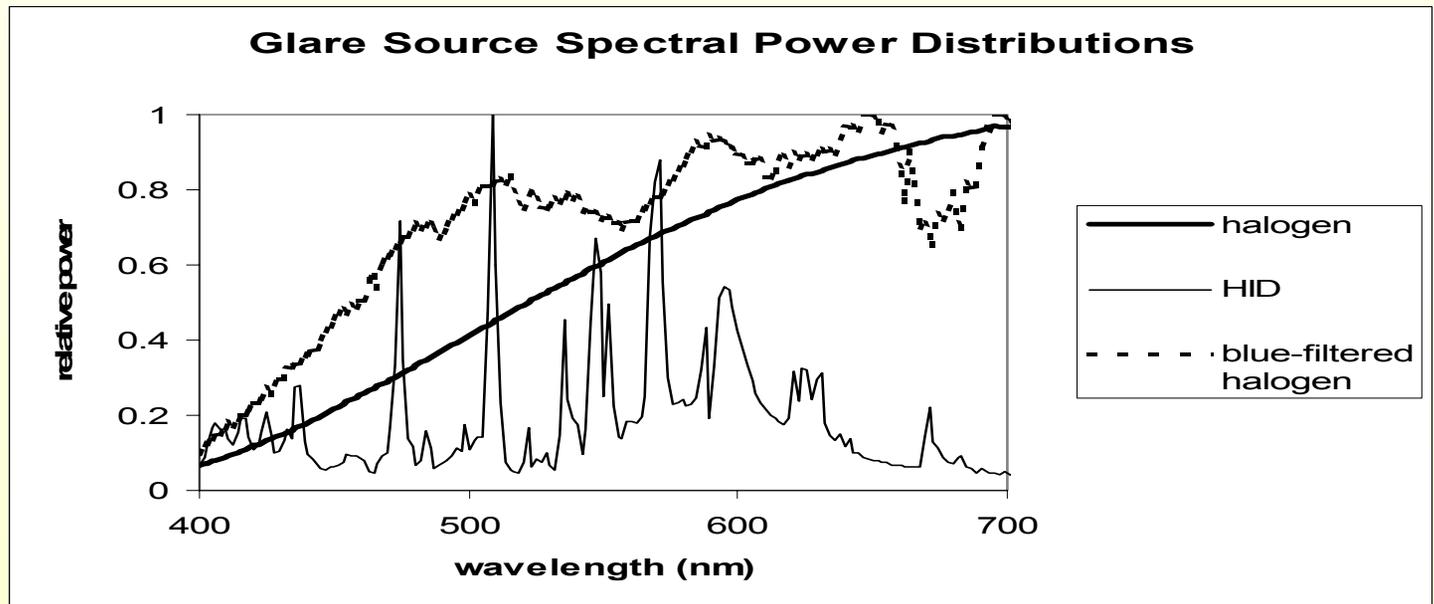
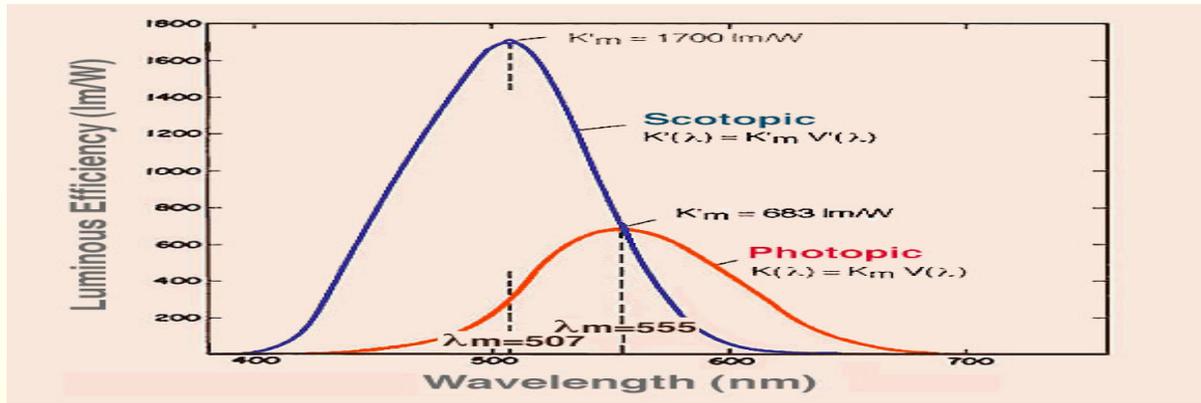
- **Disability**

- **Direct effect on visibility distance**
 - **Increases with glare intensity, driver age, and smaller angle from line of sight**

Illustration of glare effects on detectability

CONTRAST

Sensitivity of Eye to Spectrum



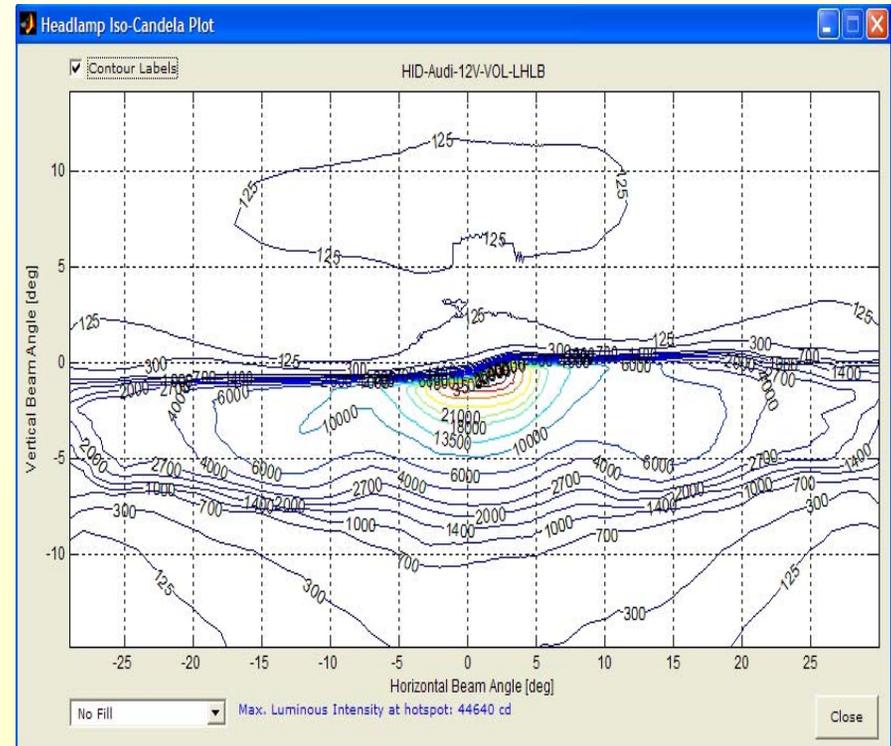
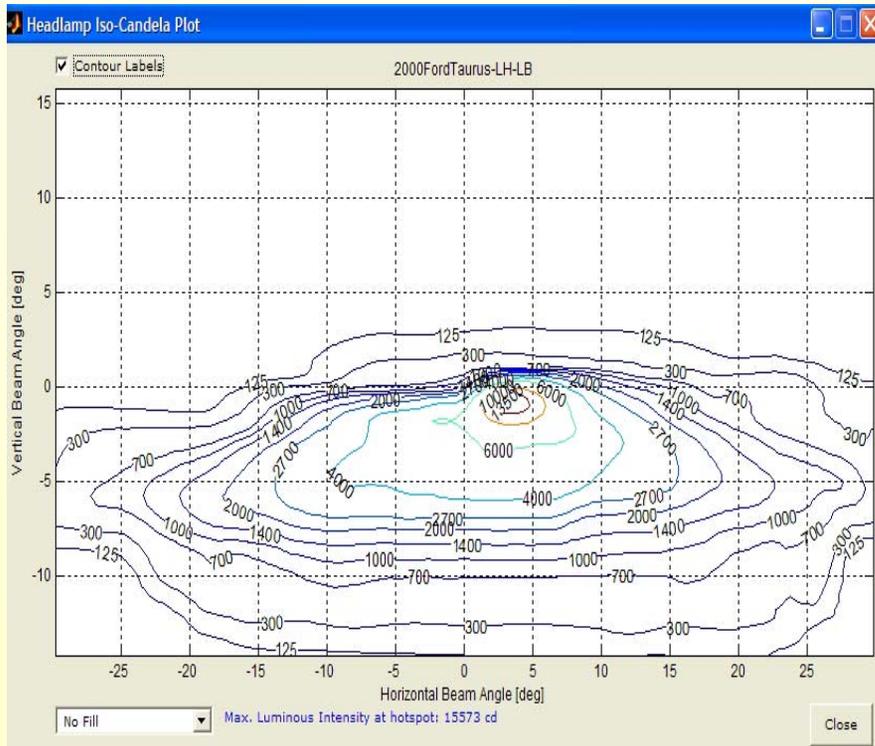
Hypotheses

- **HID Blue color: Novelty attracts attention**
- **HID Blue color: Eyes more sensitive**
- **Wider Beam Pattern: Drivers exposed to glare longer during meeting scenarios**
- **Sharper intensity gradients: More sensitive to misaim, flickering**
- **Smaller lamps: Brighter luminance**

NHTSA Glare Research

at U of Iowa (completion: Fall, 2003)

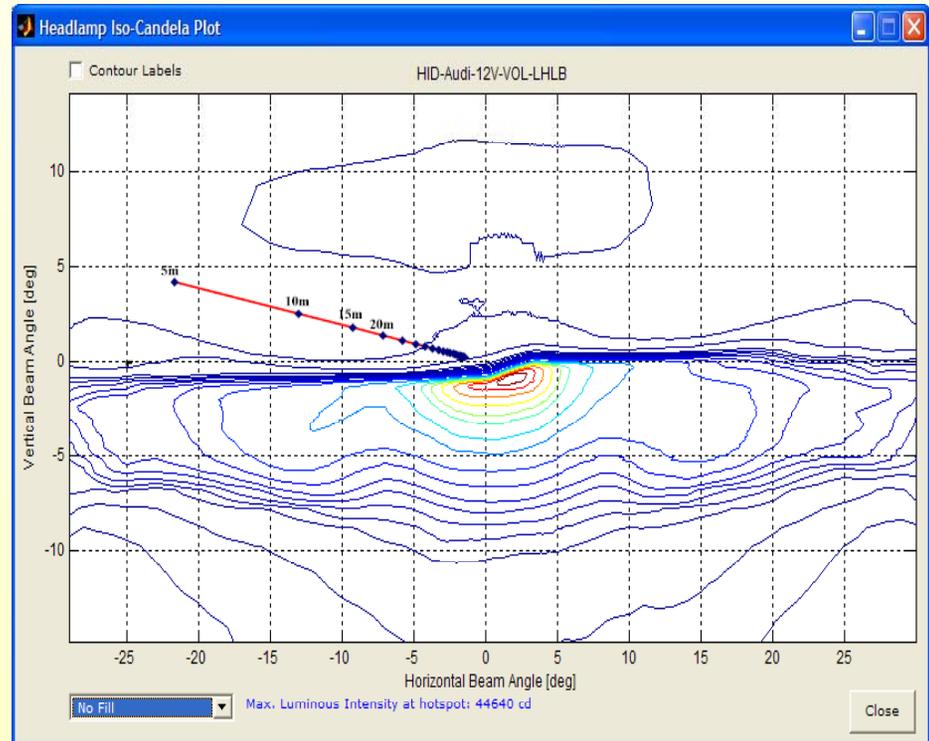
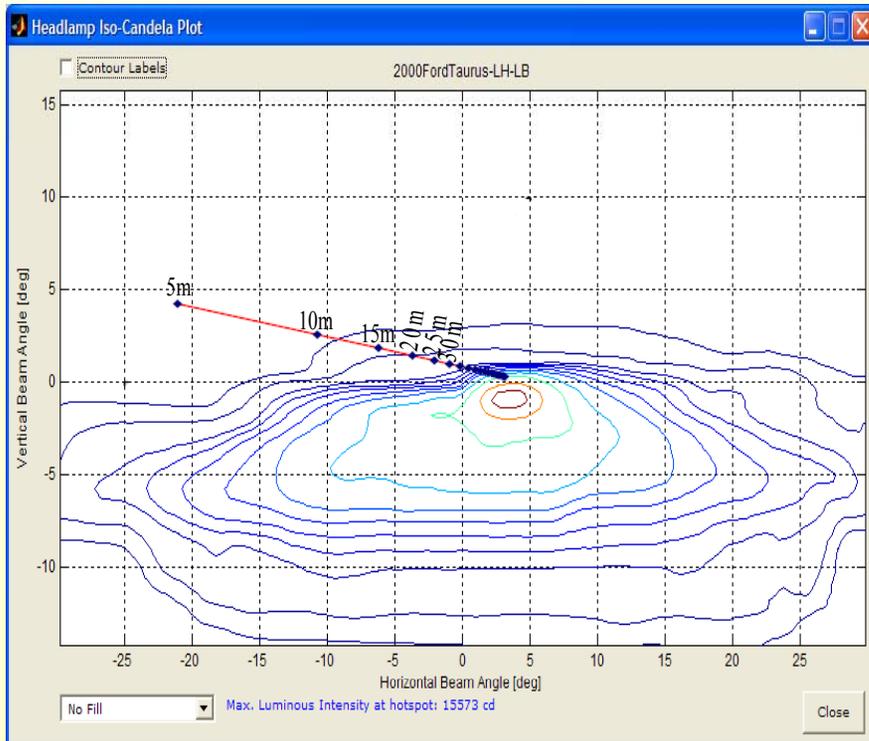
How do beam intensity distributions of HID lamps compare to Halogen lamps?



NHTSA Glare Research

(at U Iowa, completion Fall, 2003)

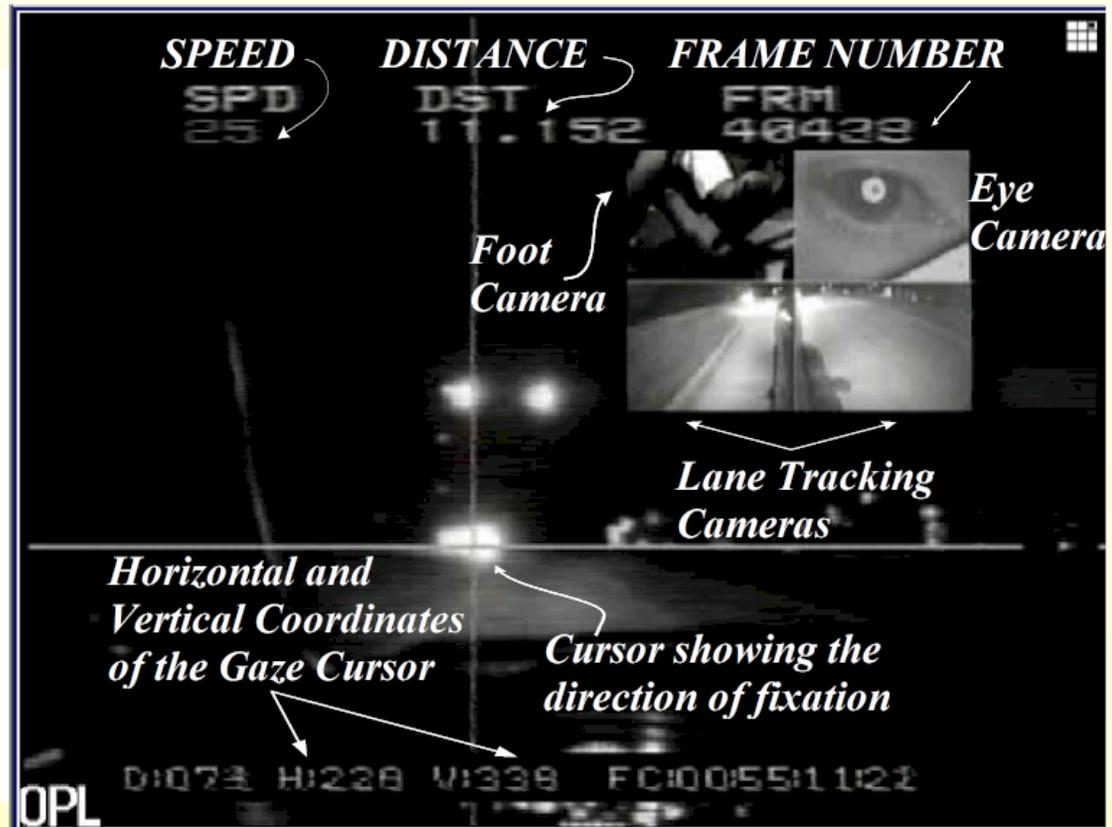
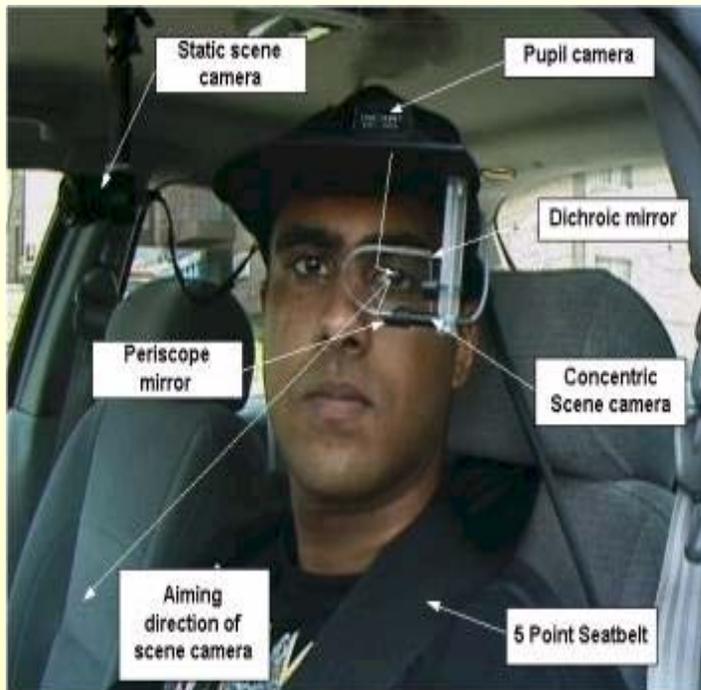
How do seeing distances and glare compare for HID and halogen lamps under different meeting scenarios, lamp aim, and mounting heights?



NHTSA Glare Research

(at U Iowa, completion Fall, 2003)

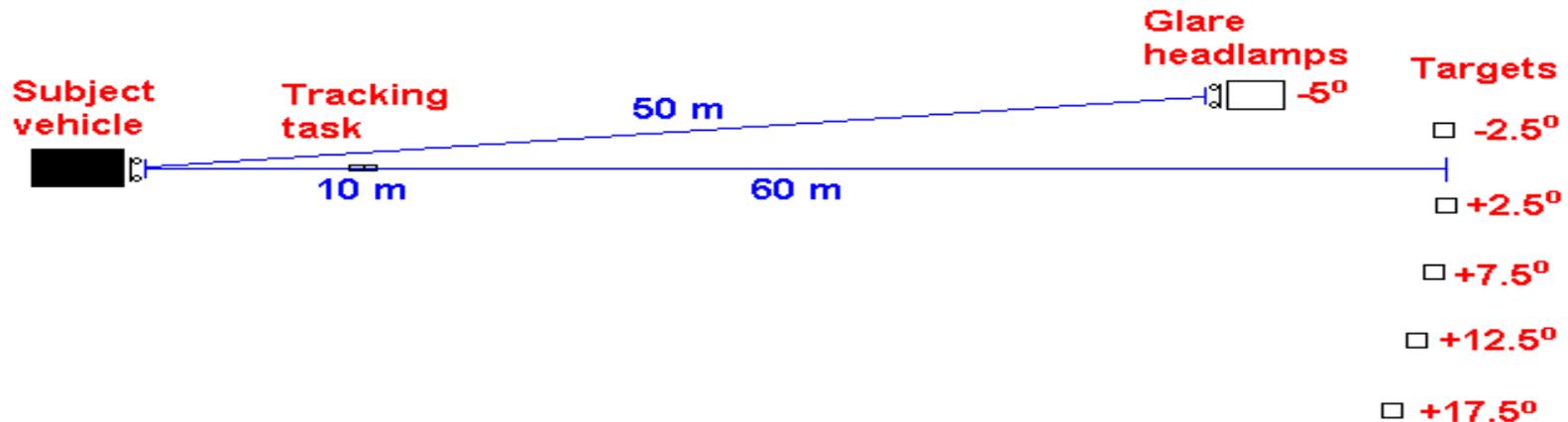
Do drivers take longer or more frequent glances at bluish headlamps?



NHTSA Glare Research

(at Rensselaer's Lighting Research Center, completion 6/2003)

Measure effects of spectral distribution, lamp size, and illuminance on glare and visual performance



- **Illuminance**: 0.2, 1, 5 lx (500, 2500, 12500 cd)
- **Spectrum**: halogen, blue-filtered halogen, HID
- **Size/luminance**: 9 cm²/1400000 cd/m², 26 cm²/480000 cd/m², 77 cm²/ 160000 cd/m²

Preliminary Findings

	Disability Glare	Discomfort Glare
Illuminance	Significant	Significant
Spectrum	Not Significant	<i>HID</i> Significant
Size	Not Significant	Not significant But trend

Preliminary Conclusions: Intensity, Spectrum, Lamp Size

- **Current FMVSS method to photometer lamp intensity seems sufficient to predict disability glare for foveal and peripheral vision**
- **For discomfort glare,**
 - **illuminance has greatest effect**
(implications for beam intensity and aiming)
 - **spectrum is much smaller effect**
(HID more discomforting)
 - **size much less so**

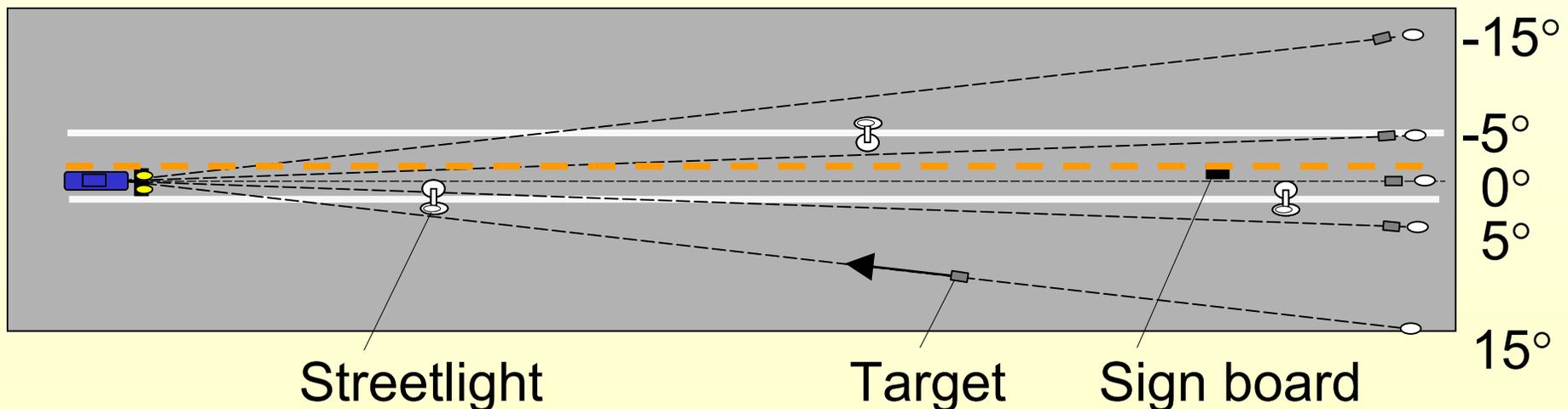
NHTSA Research

(at Rensselaer's Lighting Research Center, completion 9/2003)

Feasibility of an adaptive headlight system which reduces intensity on lighted roads

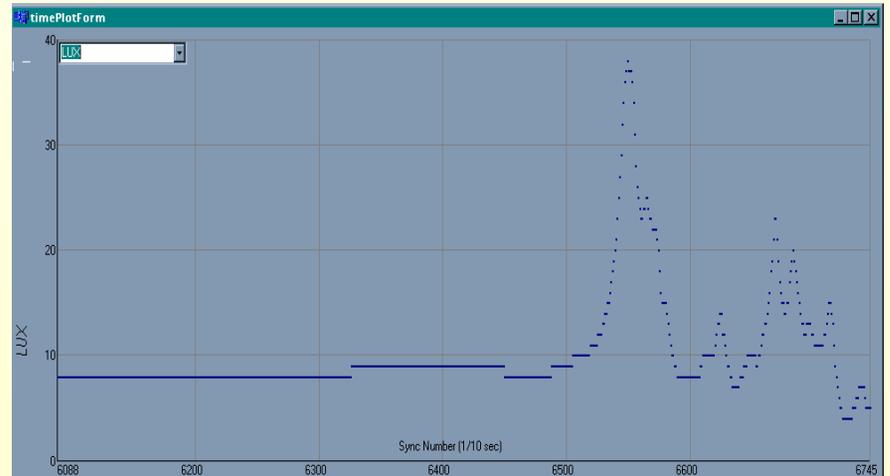
Objectives:

- Measure visual performance with reduced headlamp intensity on lighted roads
- Determine improvement in discomfort and disability glare from reduced headlamp intensity



Future Glare Research

- Use photo-logging technique to study real world glare exposure and effects on driving behaviors (2003-04)



Future Research (2003-04)

- **Determine effect of duration & intensity of HID glare exposure on visual recovery time**
- **Quantify the level of misaim of different headlamp designs; assess effect of lens degradation**
- **Further exploration of Adaptive Forward Lighting to determine its effect on visibility and glare**